Validating Microgravity Mobility Models for Hopping/Tumbling Robots

Problem Statement

- *Controlled* mobility of robotic platforms in low gravity environments (10^{-4} to 10^{-2} g) is a key technology priority for NASA and other space agencies
- Proposed platform relies on *internal* actuation mechanisms and can both hop (for large surface coverage) and tumble (for fine mobility)
- The microgravity environment achievable with parabolic flights allows to test three key aspects (not testable in Earth gravity): (1) assessment of hopping direction control, (2) assessment of tumbling control, (3) assessment of the "dynamical envelope" of these unique platforms

Technology Development Team

- PI: Dr. Issa Nesnas, NASA Jet Propulsion Laboratory
- Funding from NASA CIF and JPL RTD programs
- Co-I: Prof. Marco Pavone, Department of Aeronautics and Astronautics, Stanford University

Proposed Flight Experiment

Experiment Readiness:

- The experiment will be ready for flight in April 2014. The two robotic platforms to be tested are already at TRL 4. The experimental box containing the platforms will require minimal engineering.

Test Vehicles:

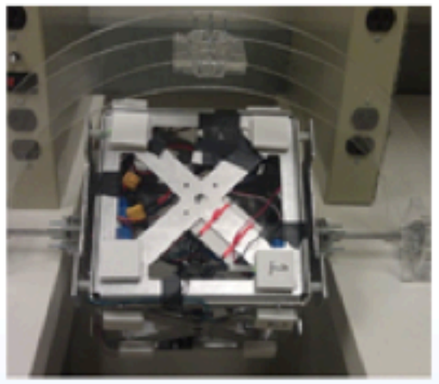
- Parabolic aircraft (lunar gravity and microgravity)

Test Environment:

- Experiment has not previously been flown

Test Apparatus Description:

1. Payload box (100kg) anchored to the fuselage and sealed shut during each flight.
2. Robotic platforms (6kg) operating inside the payload box. Two different platforms with different actuation mechanisms will be tested
3. Regolith simulant (10kg) sealed inside an additional container that is affixed to the floor inside the payload box.
4. Measurement devices (14kg) secured and protected inside the payload box.



Mobility platforms to be tested

Technology Maturation

- At the end of the campaign, the *mobility* subsystem would be at TRL 4.5
- The next step would be to develop the *sensing and localization* subsystem and test autonomous operations during a 2015 parabolic flight campaign
- Deadline: None but current funding end September 2014

Objective of Proposed Experiment

1. To assess the ability to control tumble maneuvers that roll the craft from one face to another on different terrain types
2. To assess the ability to control hop maneuvers (direction and length) on different terrain types
3. To characterize hop properties (min/max hop angle, max hop distance and accuracy of hop direction) on different terrain types

Controlled mobility has *never* been demonstrated in a relevant low-gravity environment. The aforementioned objectives represent key steps to develop this technology

List applicable Technology Areas addressed by your technology: [TA04]: Robotics, Tele-Robotics and Autonomous System, [TA07]: Human Exploration Destinations Systems

Timestamp 01/16/ 2014